

Design and implementation of community express delivery system

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ABSTRACT

The development of a community express delivery system in the context of COVID-19 reduces the risk of virus infection for people in the community who go out to pick up their deliveries, which highlights the benefits of “contactless delivery”. The system is developed using a separate development method for the front-end and back-end. The mobile end in the front end uses the WeChat applet, and the Web end uses the Vue framework for development. The back-end server is developed in Java and designed with a MySQL database. This system contributes to the community residents’ courier delivery challenges.

Keywords: Courier delivery system, contactless delivery, COVID-19, WeChat applet

1. INTRODUCTION

The global outbreak of COVID-19 at the end of 2019, according to the latest WHO real-time statistics, as of 18:04 CET on 16 May (00:04 BST on 17 May), the cumulative number of confirmed new cases of pneumonia worldwide was 519,105,112 and the cumulative number of deaths was 6,266,324. The number of countries and territories with cumulative confirmed cases exceeding 10,000 worldwide has reached 171¹. In a recent study published in the international journal “Environmental Pollution”, it was shown that: “the rapid spread of COVID-19 in the globe is closely related to its strong contagiousness,” it also states that controlling the reduction of the number of people going out and avoiding crowd gathering is an effective way to prevent and control outbreaks². Xiaoyan Miao of Beijing Jiaotong University mentioned that consumers were restricted from going out during the epidemic and their demand for offline purchases could not be fulfilled, turning to increased online purchases³. However, it also poses significant problems and risks, such as the gathering of people and vehicles at community entrances and exits during peak pick-up times, which increases the risk of virus transmission. There is also the problem of the “last kilometer” as shown in Figure 1⁴. This has led to a new research question: How to achieve safe and efficient delivery of community couriers in the event of an outbreak. Due to the specific needs of the epidemic, “contactless delivery” services have gradually become the new norm in people’s daily lives, such as delivery cabinets in the community, contactless food pick-up cabinets, unmanned convenience stores, and unmanned delivery robots and drones. During the epidemic, “contactless delivery” services have become almost standard in the logistics industry⁵. The system helps prevent and control COVID-19 in the community and addresses the “last kilometer” problem, as shown in Figure 2⁶. This system provides a temporary contract between the user and the courier delivery person. This system provides a temporary contract between the user and the courier delivery person. The courier delivery person, who is essentially from the community, takes the order posted by the user and is responsible for taking the delivery from the post and delivering it to the user. This reduces footfall at the entrance to the community, reduces the risk of new infections in the community, and provides some job opportunities for people who are not working in the community.

2. ANALYSIS OF SYSTEM REQUIREMENTS

The explosion of COVID-19 has had a huge impact on people’s production and lives. Various industries have also used and incorporated information technology to make dramatic changes⁷. In today’s COVID-19 situation, the community courier delivery system has to be used by the consignee, courier delivery staff, and the system administrator by logging into separate ports. User functional requirements are mainly online order generation, online order inquiry, secure courier pick-up, online payment, etc. Courier delivery staff’s functional requirements are mainly online pick-up orders, online query orders, courier information access, order confirmation completion, etc. The system administrator needs to have the management function of the whole platform.

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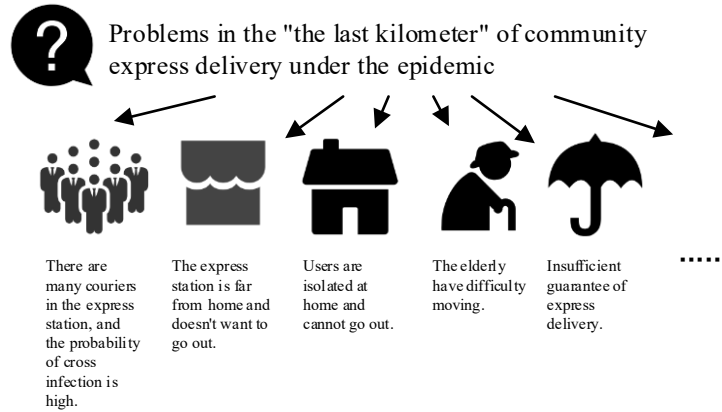


Figure 1. Communities have a "last kilometre" problem.

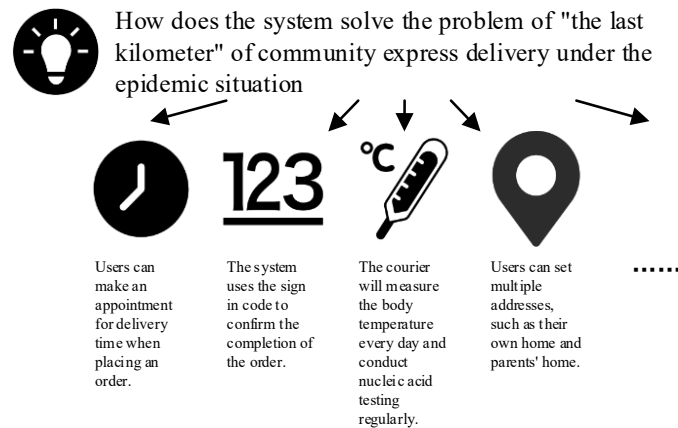


Figure 2. Solving the "last kilometre" problem with systems.

3. ANALYSIS OF SYSTEM DEVELOPMENT

3.1 Analysis of project development

The system is developed with a mobile WeChat applet and a web-based administrator backend management system. The WeChat applet on the mobile side was developed using WeChat developer tools. The administrator's web backend management site is developed based on SpringBoot + Vue front and back-end separation, while Vue also uses the Element-UI framework. The backend system is mainly developed in Java, using the SpringBoot framework and the excellent persistence layer framework MyBatis. To cater for simultaneous access by multiple users, not only MySQL, a relational database, but also Redis, a non-relational database, is used. Redis is a C-based database that supports high concurrency and performance, using key-value pairs to store data. Redis stores data in memory and is very fast to read, so it can respond quickly when accessed by multiple users at the same time.

3.2 Analysis of system functions

According to the previous analysis of the system user requirements, the functions required for the community courier delivery system are collated.

(1) According to the user's authority can be divided into ordinary users, courier deliverers, and system administrators. Ordinary users can publish orders, view orders, delete orders and modify personal information. Courier deliverers need to have the ability to order taking and query orders. System Administrator: Manage users' orders through the system log management system.

(2) The system interaction page is divided according to permissions. System administrators can only log in and operate on the website to manage the background data and system logs. Ordinary users perform a series of operations such as logging in, registering, posting orders, querying orders, and deleting orders through the WeChat applet. Courier deliverers can see available orders and check order details, etc.

(3) Ordinary users are required to register for an account before using the system, and the account must be registered using a mobile phone number as the account name.

(4) Ordinary users can apply to become a Community Courier by clicking on the corresponding button on the “My” page and are required to authenticate their real name and person and provide a valid nucleic acid test report in the context of the COVID-19.

(5) Community courier deliverers need to have a regular user account and then become community courier deliverers by submitting an application and passing certification.

(6) The system also has a good extension. The current functions of the system may be only part of the system, to leave room for future expansion of the system. First of all, it is necessary to control the user’s authority, and then design each module based on clear authority. If there are similar modules, it is necessary to optimize the data table, and reduce the number of database tables, to reduce the database data redundancy.

3.3 Analysis of system data flows

A Data Flow Diagram (DFD) is a functional model and a tool. The use of a Data Flow Diagram during the system requirements analysis phase allows the data flow process of the system to be clearer, thus providing a reference during the overall system design⁸. Through the demand analysis of system users, the data flow and data flow diagram of the system can be sorted out, as shown in Figure 3.

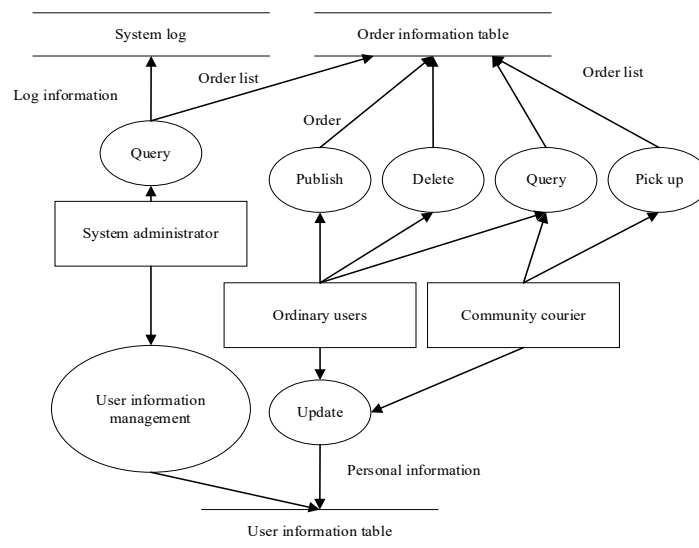


Figure 3. System data flow diagram.

3.4 Analysis of system feasibility

Before developing a system not only a requirements analysis is needed, but also a feasibility analysis. The purpose of feasibility analysis is to determine whether a problem can be solved in the shortest possible time and at the least possible cost⁹. To achieve this, it is necessary to analyze the reasonableness of the system from several aspects and to determine whether the system objectives can be achieved. From there, a more superior and available technical solution can be chosen for the system design. With the rapid development of the courier industry today, the problem of the “last kilometer” of community courier delivery is becoming more and more apparent, and with the recent impact of COVID-19 on people’s productive lives. The community courier delivery system can mobilize scattered human resources in the community while

achieving “Contactless delivery” and making full use of social resources. Therefore, the community courier delivery system is feasible to achieve.

4. SYSTEM DESIGN

Taking all aspects into consideration, this system is designed to follow the following principles:

- The principle of advancedness.
- Principle of resource sharing.
- The principle of security and reliability.
- The principle of simplicity of operation and maintenance.
- Principle of expandability and compatibility.

4.1 System design architecture and working principles

4.1.1 System Architecture. As the network operation method used in this system is B/S the three-layer architecture is the representation layer, functional layer, and data layer. The system architecture diagram is shown in Figure 4.

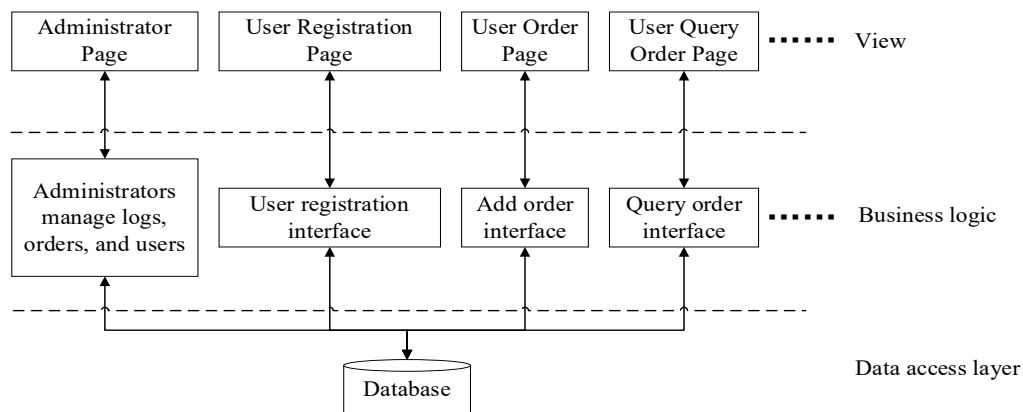


Figure 4. System architecture.

4.1.2 The Principle of How the System Works. In the B/S model, the client sends an HTTP request to the web server using the browser and needs to access the database, after the web service receives the request, it authenticates the legality of the request. If it is a legitimate request, the web server will process the request sent by the client browser and then return the processed result to the client browser, after the client browser receives the returned data. When the client browser receives the returned data, it will process the data and render it on the browser page¹⁰.

4.2 Overall system design

4.2.1 System Functional Module Design. The system is designed with a user login and registration module, a user release order module, a user inquiry order module as well as an administrator management module. The system functional module diagram is shown in Figure 5.

4.2.2 System Process Design.

The main flow of the system is shown in Figure 6. ordinary users: Users can open the WeChat applet then go to the applet and register or log in to the system. If you fail to log in, you will be prompted with a pop-up window; if you succeed, you can start using the normal user last option is to choose whether or not to log out. At the same time, ordinary users can also apply to become a courier, you need to authenticate, body temperature test, provide a nucleic acid test report within 48 hours, etc., the authentication is passed, then enter the courier process. Courier: open the WeChat applet, enter the login page, and log in to the system, if the login fails, there will be a pop-up window prompt. If the login is successful, you can start using the courier functions: receiving and checking orders, etc. Finally, you can choose whether to log out.

Administrator: the administrator logs into the system via a dedicated webpage, when logging in, it will first determine if the visitor is an administrator, if not there will be a pop-up window. If successful, the visitor will be given administrator rights to manage users, orders, and system logs, to query and update user information and order information, as well as system log files to observe and maintain the system status. The administrator can log out of the login if he/she chooses to do so. The main flow design of the system is shown in Figure 7.

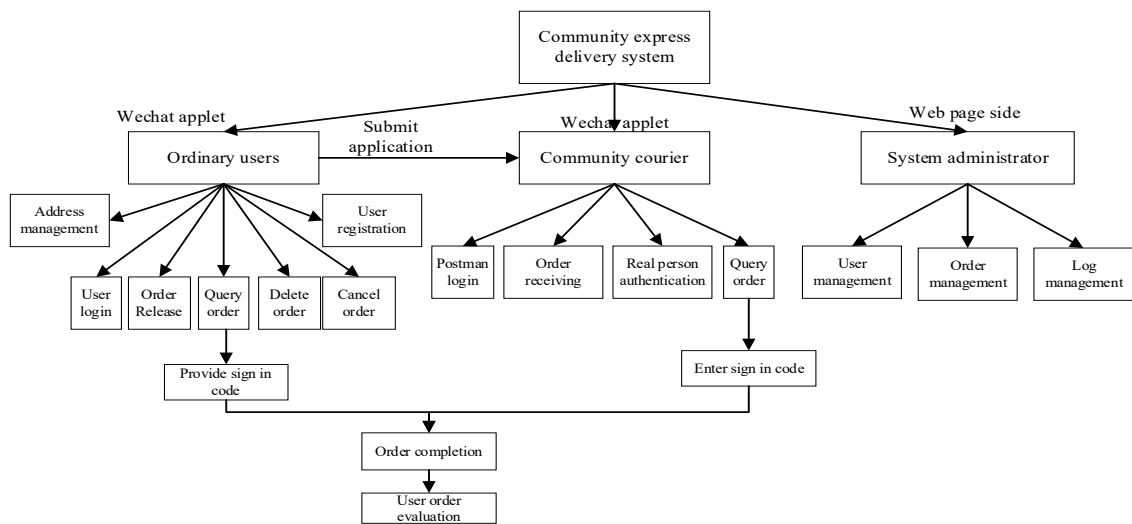


Figure 5. System block diagram.

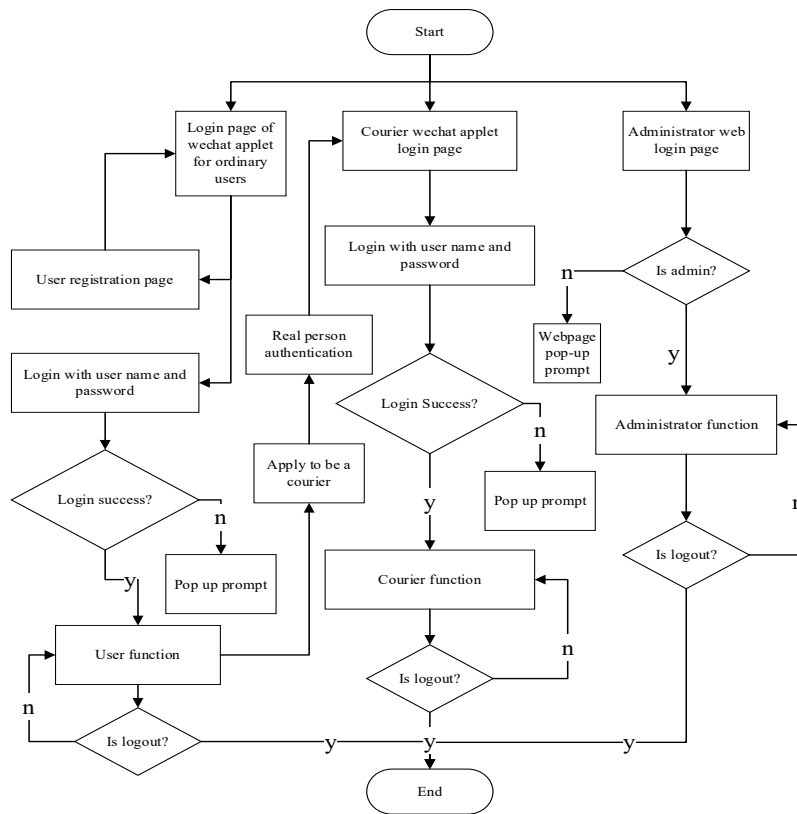


Figure 6. System flow chart.

4.2.2.1 Brief description of the system deployment

- WeChat applet front-end: WeChat needs to be installed first.
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- Server: use of Tomcat 9.0.
- Database server: using MySQL 8.0.28, a relational database, and Redis, a non-relational database.

4.2.2.2 Connection constraints:

- Both the WeChat applet front-end and the VUE front-end use the HTTP protocol to interact with the server, provided that there is an internet connection.
- The backend server uses MyBatis to connect to and access the database.

4.2.3 Business Logic Layer Design. The “Community Courier Delivery System” mainly includes user registration and login module, user release, query, cancellation, and deletion of orders module, courier delivery personnel pick up and query orders module, courier delivery personnel real person authentication module, system management, and maintenance module, etc. Therefore, the system can be divided according to the following modules.

4.2.3.1 User registration and login module design:

- User registration: If the user does not have an account, he/she needs to register an account first.
- User login: normal user login, courier login, and an administrator login. Ordinary user login and courier delivery login are both logged in using username password login on the WeChat applet. Normal users can use the system functions normally once they have successfully logged in. Once the courier deliverer login is successful, he/she will be able to use the functions that only courier deliverers can use. Administrator user login is done on the VUE front-end server. The administrator needs to open the administrator-specific login page in the browser and use the username and password to complete the login.

4.2.3.2 User release order module design: As shown in Figure 7, users can use this module to publish orders, orders require the user to provide information about the courier, including pick-up code, pick-up post address, and delivery address, etc. At the same time, the system will calculate the corresponding cost according to the weight of the parcel, type, delivery distance, and other factors, the order will be prepaid, if you need to cancel the order, then the prepaid fee will be returned to the original payment account within 24 hours. After the order is successfully posted, the user will be given a four-digit receipt code generated by the backend system. When the courier delivers the parcel to the user, the courier will ask for the receipt code to complete the order.

4.2.3.3 Order pick-up module design for delivery staff: The delivery person can view the orders available for pick up and once picked up successfully, they can see the information inside the order details as shown in Figure 8.

4.2.3.4 User query order module design: Users can query all orders about themselves in this module, and can also set filter conditions to query order information.

Order Releasing
Business hours 8:00-18:00

Pickup code: Please enter the pickup code

tracking number: Please enter the courier number

Choose an inn: Rookie station/Jade Rabbit Inn

delivery information: San Zhang 1598888888
Recently used 405, Unit 3, Block C, Huajinyuan

Name on the package: Please enter Name on the package

Appointment: Appointment today 11:00-13:00

item information: Daily necessities/1kg

coupon: Reduce 1 yuan

Platform rights: View detail

Speed Lose weight privacy protection

☐ I have read and agreed to the "Service Agreement" "license information"
After filling in the receipt address, see the estimated delivery fee
Prediction of items in 1 kg

Submit

Figure 7. User order release.

Order detail

order number: 0000203032 Delivery fee: 5 yuan

Order receiving Take parts Sending Sign for

Pickup Station: rookie station

Pickup code: 2-2-4056

Shipping Address: 405, Unit 3, Block C, Huajinyuan

recipient: San Zhang

Recipient's mobile number: 1598888888

Name on the package: Xiao Zhang

Item information: Daily necessities/1kg

Appointment: April 6, 2022, 11:00-13:00

sign code: Please enter the four-digit receipt code provided by the customer

Finish

Figure 8. The postman checks the order details.

Welcome to the background management system
Administrator

Set the pop-up position of filter criteria:
☐ Open from left to right
☒ Open from right to left
☐ Open from top to bottom
☐ Open from bottom to top

[Click me to set filter criteria](#)

Order List	Order Title	Order Status	Operation
> ☐ 13	SIHASIKA	0	Edit Delete
> ☐ 12	TTTTTTT	0	Edit Delete
> ☐ 7	ceshi	1	Edit Delete
> ☐ 4	123456789	0	Edit Delete
> ☐ 3	123	0	Edit Delete
> ☐ 2	Title2	0	Edit Delete
> ☐ 1	Title1	1	Edit Delete

[Batch Delete](#)

Figure 9. The administrator manages the order list.

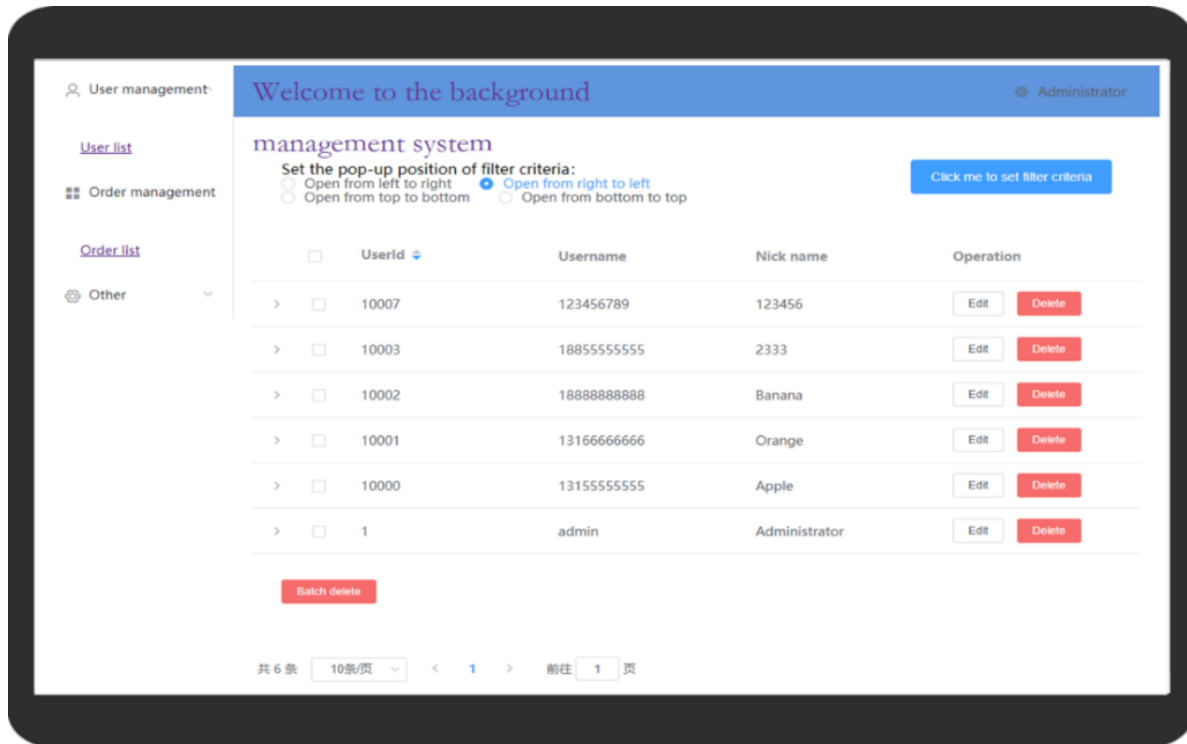


Figure 10. Administrators manage user lists.

4.2.3.5 System management and maintenance module design:

- Order information management: As shown in Figure 9, the administrator can set filter conditions to query the orders that meet the specified conditions, and the administrator can update or delete certain order information.
- User information management: As shown in Figure 10, the administrator can set filtering conditions to query the information of users with specified conditions. At the same time, the administrator can also modify and delete a user's information.
- System Log Management: The system log records information about the operation of the system and generates a log file to be stored on the server. The administrator can use the log files to maintain the system.
- In addition to the above functions, some minor functions can be added to the system, such as paging of data pages, friend-tip functions, etc.

4.2.3.6 COVID-19 prevention and control module design: The COVID-19 prevention and control module is mainly for each courier deliverer. Users need to have an ordinary user account before becoming a courier, and then they need to submit a form with relevant information to become a courier, undergo real-person authentication, and finally, pass the system administrator's audit before they can become a courier. Courier delivery personnel are required to have their body temperature checked daily and undergo regular nucleic acid testing.

4.3 The impact of the system

The system creates a temporary contractual relationship between ordinary users and couriers, providing a paid home delivery service for ordinary users and employment opportunities for unemployed people in the community to become "couriers". This has helped and supported the community in the prevention and control of COVID-19, for example by avoiding large gatherings of people and unnecessary human contact when residents pick up their deliveries. This service is particularly helpful for residents with larger and heavier items and those with limited mobility. Finally, after enjoying this service, the user can rate the service on the order page to improve the system in time.

5. CONCLUSION

This paper was designed to address the “last kilometer” problem of courier delivery from the post to the user during the COVID-19 phase. The community courier delivery system in the context of COVID-19 has been implemented from requirement analysis to requirement outline design, and then developed through technical means. The user side of the WeChat app is developed based on the WeChat applet, which does not take up too much memory space on the phone, and the experience of using it is no less than that of an Android app. Furthermore, WeChat applets are mainly developed based on the Html5 language, which is highly portable and easy to maintain code. The Vue framework used on the administrator’s website is also a more popular front-end framework, with support from many excellent third-party frameworks, and is very easy to develop. The server back-end, developed in Java, also uses the most popular Spring Boot framework. The original community courier all required residents to go from their homes to a nearby courier post to provide a pick-up code to pick up the courier. The emergence of the system, breaking people’s previous inherent perception of picking up couriers, gives users a new option to pay a small fee to enjoy the delivery of courier services without leaving home. The system not only solves the problem of community residents trying to avoid going out to pick up items to reduce the risk of contracting COVID-19 in the context of today’s COVID-19, but also provides good employment opportunities for some unemployed residents who are staying at home, and thus has good market prospects.

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